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SHORT FIBER CONTENT OF COTTONS IN RELATION TO OTHER QUALITY MEASUREMENTS

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SHORT FIBER CONTENT OF COTTONS IN RELATION TO OTHER QUALITY MEASUREMENTS

by

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Short fiber content of cotton has been recognized as an undesirable fiber quality characteristic for many years. The textile comber was developed about 1846 to remove short fibers and produce a higher quality end-product in cotton textile processing. The inferiority of shorter fibers also has been reflected in the market place as price discounts for the shorter staples and premiums for the longer staples. The late Fred Taylor made the following statements regarding short fiber in a report 2/ which was published in 1914:

> "They believe the eastern staples to be more wasty, that is to say that they contain a large proportion of short fiber which will be taken out as waste in the manufacture of combed yarns.
>
> "The greatest care on the part of buyers in stapling cotton will not reveal the difference between staples which contain 10 and 20 percent of comber waste, respectively."

Dr. Robert W. Webb also made the following statements regarding cotton quailty in a report 3/ which was published in 1929:

> "Strong protests recently came to the Department of Agriculture from various sources in this country and abroad to the effect that the ginning preparation of American cotton is not as good as it used to be. That is, the ginned lint now appears on the whole to be rougher, more gin cut, and

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1/ The assistance of co-workers in the Standards and Testing Branch, Cotton Division, Agricultural Marketing Service, is gratefully acknowledged.

2/ Spinning Tests of Upland Long-Staple Cottons, by Fred Taylor, U. S. Department of Agriculture Bulletin No. 121, June 1914.

3/ Problems and Research Methods in Cotton Ginning, by Robert W. Webb, U. S. Department of Agriculture, BAE, Division of Cotton Marketing, April 1929.

more neppy than formerly. Of course, if the fibers on the seed in the beginning do not possess good qualities such as length, uniformity of length, body, strength, etc., even the most excellent ginning would not and could not improve these qualities. On the other hand, if the fibers on the seed do possess the desirable qualities, the operations of cleaning and ginning, if not correctly performed, may damage the fibers and thereby reduce these spinning qualities.

"A series of graphs is shown in Figures 4 and 5 for the saw-ginned lint and for the hand-pulled lint from the same lot of seed cotton. Upon examining the graphs, it is apparent that this is not as perfect a job of ginning as that shown in Figures 2 and 3. For instance, about 47 percent of the saw-ginned lint is 3/4 of an inch or more in length as contrasted with about 65 percent in the case of the corresponding hand-pulled sample. In other words, the saw gin or the cleaning equipment, or both, reduced the percentage of long fibers and increased those of the short fibers through cutting, breakage or injury."

Recently the short fiber content of cottons has become a lively subject in the textile industry in connection with harvesting, ginning and spinning studies. It is one of several designations such as wasty, length variation, and length uniformity which are used to describe the length-distribution of the fibers in cotton samples. These designations or values are usually used in conjunction with length designations such as staple length, mean length and upper quartile length. The laboratory measurement most commonly referred to as short fiber content has been the percentage of fibers shorter than 1/2-inch as determined by the Suter-Webb array sorter method 4/. This and other length measurements were performed by the Cotton Division on samples of cotton from bales used in the grade and staple standards 5/ and on samples of cotton included in the Annual Cotton Quality Survey, crop of 1960 6/

4/ Standard Method of Test for Length and Length Distribution of Cotton Fibers by the Array Method, ASTM Designation: D 1440-55 ASTM Standards on Textile Materials, October 1961

5/ Short Fiber Content of Cottons, Test Results for Several Hundred Bales, U. S. Department of Agriculture, AMS-413, October 1960

6/ Annual Quality Survey, Summary of Results of Fiber and Processing Tests from Selected Market Areas, Crop of 1960, Agricultural Information Bulletin No. 236, March 1961

because of the unusual interest in the subject. These tests were performed to evaluate measurements of the short fiber content of cottons in relation to other quality measurements.

Results from studies of 443 samples of medium staple cottons in the 1960 Annual Cotton Quality Survey and of 111 samples of medium staple bales in the grade and staple standards show that short fiber content is associated with other fiber characteristics. The average association of short fiber content with other selected fiber quality measurements, as listed in table 1, show lower percentages of fibers shorter than 1/2-inch by the array method for either the higher grades, the longer staples, the higher Micronaire readings, the higher Pressley strengths, the longer upper quartile lengths, or the lower coefficients of length variation. These average values were calculated from the results of simple correlation analyses shown in table 4 at the end of the report.

Table 1.--Average short fiber content showing its association with selected fiber quality measurements

Selected measurement and its value	Average short fiber percent	Selected measurement and its value	Average short fiber percent
Grade designation:		Pressley strength:	
LM	12.1	75	11.7
SLM	11.0	80	10.9
M	10.2	85	10.1
SM	9.8	90	9.2
Staple length:		Upper quartile length:	
1"	12.7	1.10"	12.9
1-1/32"	11.5	1.15"	11.5
1-1/16"	10.3	1.20"	10.0
1-3/32"	9.0	1.25"	8.5
Micronaire reading:		Coef. of length variation:	
3.5	11.2	24	4.2
4.0	10.9	28	7.6
4.5	10.6	32	10.8
5.0	10.3	36	14.1

Results for the medium staple samples in both the Annual Cotton Quality Survey and the standards studies also show that short fiber

content is associated with spinning test results, but the addition of short fiber content to the combination of upper quartile length and coefficient of variation does not improve the relationship with either yarn strength or spinning potential yarn number 7/. Correlation coefficients as listed in table 2 show that the addition of either coefficient of variation or short fiber content to upper quartile length improves the relationship with spinning test results but the addition of both items does not result in further improvement in the relationship. These correlation coefficients designate perfect agreement by a value of one and designate no agreement by a value of zero. Other results of the correlation analyses are also shown in table 5 at the end of the report.

Table 2.--Correlation coefficients showing relative association of short fiber content with spinning test results when used in conjunction with other length measurements

Combination of length measurements	Strength of 22s yarn: Annual Quality	Strength of 22s yarn: Standards bales	Spinning Potential: Standards bales
Upper quartile only	0.39	0.59	0.83
Upper quartile and coefficient of variation	.55	.71	.86
Upper quartile, coefficient of variation & short fiber	.55	.71	.87
Upper quartile and short fiber	.55	.71	.86

Both carded and combed yarn spinning tests were performed on 39 medium staple samples and 31 long staple samples in the 1960 Annual Cotton Quality Survey. The carded sliver from each of these samples was divided into two separate portions to provide the material for both the carded and the combed yarns. Most of the short fibers remained in the carded yarn portion but were combed out of the combed yarn portion. The results of these tests as listed in table 3,

7/ A Method of Evaluating Spinning Performance of Cotton, by S. T. Burley and Frank S. Eddins, U. S. Department of Agriculture No. AMS-299, February 1959

however, show that the combed yarns have essentially the same relationship of yarn quality to raw cotton short fiber content in spite of the fact that most of the short fibers were removed from the combed yarns. We have construed this to indicate that most of the differences either in carded or combed spinning test results for cottons of different raw cotton short fiber content can be attributed to differences in other fiber characteristics. Other fiber and spinning test results for these samples are shown in table 6 at the end of the report.

Table 3.--Average quality measurements of both carded and combed yarns processed from cottons of different short fiber content

Yarn quality measurement and short fiber designation	Medium Staples		Long Staples	
	carded yarns	combed yarns	carded yarns	combed yarns
Strength of 22s for:				
Low short fiber	122	132	136	146
Medium short fiber	111	122	134	144
High short fiber	104	118	130	141
Appearance index for:				
Low short fiber	104	111	96	104
Medium short fiber	98	106	93	102
High short fiber	98	106	85	97
Imperfections in 22s for:				
Low short fiber	18	10	24	15
Medium short fiber	22	13	23	16
High short fiber	20	12	31	17

The array sorter method is too slow and tedious for most routine quality evaluation tests and it is the only method generally accepted for the determination of short fiber content. Two well-trained technicians can test only 7 samples per day when 2 determinations are made per sample to provide the bare minimum in accuracy of results. Other faster methods of tests for short fiber content of cottons have been used, but neither they nor the array methods have proven to be satisfactory. Tests for length and length uniformity, on the other hand, have proven to be both more reproducible and more easily performed. These length and length uniformity results are as highly correlated with the results of spinning tests as is the percent short fiber.

Although short fiber content is an important fiber characteristic, its measurement is impractical for most routine test evaluations

because it adds nothing to the quality evaluations obtained with other measurements which are more easily performed. Continued use of length uniformity in association with length to evaluate this aspect of cotton quality is a more practical procedure. Results based on these measures provide as good or better cotton quality information at much less cost than results based on measures of short fiber content.

Table 4.--Short fiber content of medium staple cottons as related to other fiber properties

Fiber property and Statistical item	Relationship with array short fiber content for Annual Quality 1/	Standards 2/
Grade index:		
Correlation Coef. (r)	- 0.23	- 0.32
Std. error of est. (s)	± 2.8	± 2.7
Regression const. (a)	23.9	21.6
Regression coef. (b)	- .14	- .11
Mean and Std. dev. (X)	96.7 ± 4.7	96.8 ± 8.3
Staple length:		
Correlation Coef. (r)	- 0.32	- 0.48
Std. error of est. (s)	± 2.7	± 2.5
Regression const. (a)	54.9	48.6
Regression coef. (b)	- 1.32	- 1.12
Mean and std. dev. (X)	33.7 ± 0.7	33.6 ± 1.2
Micronaire:		
Correlation Coef. (r)	- 0.06	- 0.12
Std. error of est. (s)	± 2.9	± 2.8
Regression const. (a)	12.3	13.9
Regression coef. (b)	- .44	- .67
Mean and std. dev. (X)	4.4 ± 0.4	4.4 ± 0.5
Pressley strength:		
Correlation Coef. (r)	- 0.39	- 0.35
Std. error of est. (s)	± 2.7	± 2.6
Regression const. (a)	25.1	23.0
Regression coef. (b)	- .18	- .15
Mean and std. dev. (X)	81.9 ± 6.4	80.3 ± 6.6
Upper quartile length:		
Correlation coef. (r)	- 0.58	- 0.53
Std. error of est. (s)	± 2.4	± 2.4
Regression const. (a)	54.8	36.3
Regression coef. (b)	-37.4	-22.1
Mean and std. dev. (X)	1.187 ± 0.045	1.146 ± 0.067
Coef. of length variation:		
Correlation coef. (r)	+ 0.96	+ 0.73
Std. error of est. (s)	± .8	± 1.9
Regression const. (a)	-15.5	-15.3
Regression coef. (b)	+ .82	+ .82
Mean and std. dev. (X)	31.6 ± 3.4	32.1 ± 2.5

1/ Based on 443 medium staple samples in the Annual Cotton Quality Quality Survey, Crop of 1960 which average 10.4 ± 2.9 in array short fiber content.

2/ Based on 111 medium staple samples studies of grade and staple standards which average 11.0 ± 2.8 in array short fiber content.

Table 5.--Array measurements of the fiber length of medium staple cottons as related to spinning test results

Sample identification, spinning test item, and statistical item		Relationship with spinning test results for specific array length measurements: Upper quartile, coef. of variation and short fiber	Upper quartile, and coef. of variation	Upper quartile, and short fiber	Upper quartile, only
ANNUAL QUALITY 1/:					
Strength of 22s yarn:					
Correlation coef.	(R)	0.55	0.55	0.55	0.39
Std. error of est.	(S)	± 8.8	± 8.9	± 8.9	± 9.8
Regression const.	(a)	99.3	99.3	94.5	.8
Regression coef. for:					
Upper quartile	(b)	38.2	45.3	27.9	91.9
Coef. of variation	(c)	- .9	- 1.4	none	none
Short fiber	(d)	- .6	none	- 1.7	none
STANDARDS 2/:					
Strength of 22s yarn:					
Correlation coef.	(R)	0.71	0.71	0.67	0.59
Std. error of est.	(S)	± 8.8	± 8.8	± 9.3	±10.2
Regression const.	(a)	78.9	76.6	48.1	16.2
Regression coef. for:					
Upper quartile	(b)	82.1	88.4	71.3	111.00
Coef. of variation	(c)	- 1.8	- 2.1	none	none
Short fiber	(d)	- .4	none	- 1.7	none
Spinning potential:					
Correlation coef.	(R)	0.87	0.86	0.86	0.83
Std. error of est.	(S)	± 3.8	± 3.9	± 3.8	± 4.2
Regression const.	(a)	-24.0	-26.8	-28.9	55.6
Regression coef. for:					
Upper quartile	(b)	79.0	87.0	77.3	93.7
Coef. of variation	(c)	- .3	- .7	none	none
Short fiber	(d)	- .5	none	- .7	none

1/ Based on 443 medium staple samples from the Annual Quality Survey, Crop of 1960, which average 109.9 ± 10.6 for yarn strength, 1.187 ± .045 for upper quartile, 31.6 ± 3.4 for coefficient of variation and 10.4 ± 2.9 for short fiber.

2/ Based on 111 medium staple samples from grade and staple standards which average 111.0 ± 12.6 for yarn strength, 51.72 ± 7.56 for spinning potential, 1.146 ± .067 for upper quartile length, 32.1 ± 2.5 for coefficient of variation and 11.0 ± 2.8 for short fiber content.

Table 6.--Average results of classification, fiber, carded yarn, and combed yarn tests as related to short fiber content

Identification of Test Item	Average results for Annual Quality lots of 1/					
	Medium staples with			Long staples with		
	Below 12% Short fiber	12 to 17% Short fiber	Above 17% Short fiber	Below 10% Short fiber	10 to 12% Short fiber	Above 12% Short fiber
Number of lots tested	11	18	10	7	17	7
Classification:						
Grade Index	100	95	95	100	102	102
Staple length	34.1	34.0	33.9	36.4	36.5	35.9
Fiber tests:						
Suter-Webb array						
Upper quartile	1.23	1.21	1.15	1.29	1.29	1.28
Coef. of variation	31	37	41	31	34	36
Short fiber	11	15	20	9	11	14
Digital Fibrograph:						
2.5% span length	1.08	1.08	1.07	1.14	1.15	1.13
50/2.5 uniformity	45	43	41	44	44	43
Short fiber	7	11	15	7	7	8
Micronaire reading	4.6	4.3	4.2	3.9	3.9	3.8
Pressley strength	85	79	80	87	86	86
Carded yarn tests:						
Picker & card waste	7.5	9.0	8.6	7.9	7.6	8.4
Neps in card web	16	21	23	27	27	30
Strength of 22s yarn	122	111	104	136	134	130
Appearance index	104	98	98	96	93	85
Imperfections in 22s	18	22	20	24	23	31
Combed yarn tests:						
Comber waste	17.1	18.1	20.8	15.1	16.1	18.7
Strength of 22s yarn	132	122	118	146	144	141
Appearance index	111	106	106	104	102	97
Imperfections in 22s	10	13	12	15	16	17

1/ Based on 70 samples in the Annual Cotton Quality Survey, Crop of 1960, which were processed into both carded and combed yarns.

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